



NOTES

MICROCYTIC ANEMIA

GENERALLY, WHAT IS IT?

PATHOLOGY & CAUSES

- Inherited/acquired anemias, small erythrocytes, varying hemoglobin content

SIGNS & SYMPTOMS

- Decreased oxygen to tissues → fatigue, pallor, dyspnea, activity intolerance



MNEMONIC: Find Those Small Cells Last

Microcytic anemias

Fe deficiency

Thalassemia

Sideroblastic

Chronic disease

Lead poisoning

DIAGNOSIS

LAB RESULTS

- Complete blood count (CBC), peripheral blood smear analysis, blood chemistry, iron studies

TREATMENT

OTHER INTERVENTIONS

- Nutrient replacement, packed red blood cell transfusions

IRON STUDIES IN MICROCYTIC ANEMIA

	IRON DEFICIENCY	LEAD POISONING	THALASSEMIA
IRON (SERUM)	↓	↓	Normal or ↑
FERRITIN (SERUM)	↓	↓	Normal or ↑
IRON BINDING CAPACITY	↑	↑	Normal

VISIT...

LANZAROTE
Caliente.COM

IRON-DEFICIENCY ANEMIA

osms.it/iron-deficiency-anemia

PATHOLOGY & CAUSES

- Microcytic, hypochromic anemia, small erythrocytes, decreased hemoglobin
- Insufficient iron → decreased iron for hemoglobin synthesis → impaired erythropoiesis → production of microcytic, hypochromic erythrocytes
 - Insufficient iron to synthesize hemoglobin during erythropoiesis (most common cause of anemia worldwide)

CAUSES

Insufficient intake/absorption

- Decreased intake
 - **Eating disorders** (e.g. pica, anorexia, bulimia); self-imposed **dietary restrictions** (e.g. vegan diet); food insecurity
- Decreased absorption
 - **Celiac disease, surgical resection** of gastrointestinal (GI) tract, bariatric surgery, excessive dietary calcium, tannates, oxalates

Increased need

- Increased need
 - **Pregnancy, lactation**
- Increased growth
 - Infants, children, adolescents

Increased loss

- Overt blood loss
 - Hematemesis, **trauma-related hemorrhage, heavy menses**, hematuria, multiple blood donations
- Occult
 - **GI bleed** (e.g. peptic ulcer, tumor); **vascular lesions** (e.g. hemorrhoids); hookworm/other helminthic infections

COMPLICATIONS

- High-output heart failure, angina, cardiorespiratory failure
- Infants, young children
 - Impaired growth, development

SIGNS & SYMPTOMS

Decreased oxygen to tissues

- **Pallor**
- **Fatigue**, activity intolerance, exertional dyspnea, angina
- Compensatory mechanisms
 - Palpitations, increased pulse, increased cardiac output, tachypnea, selective shunting of blood to vital organs (e.g. skin to kidneys)

Effects on epithelial tissues

- Glossitis
 - Smooth, “beefy red” tongue
- Cheilosis
 - **Scaling, fissuring; dryness; lip scaling**
- Koilonychia
 - **Spoon-shaped**, concave nails
- **Esophageal stricture**
- Gastric atrophy
- Blue sclerae
- Pagophagia
 - Obsessive **consumption of ice**

DIAGNOSIS

LAB RESULTS

- ↓ red blood cell count
- Low/normal reticulocytes
- ↓ hemoglobin, hematocrit
- Hypochromic-microcytic erythrocytes
 - **Decreased:** mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC)

- **Blood smear analysis:** erythrocytes with increased central pallor ($> \frac{1}{3}$ diameter, anisocytosis (anisto = unequal), poikilocytosis (poikilo = irregular), target cells (resemble target; center stain with pallor ring, outside stain ring)
- **Iron studies**
 - **Decreased serum iron**, ferritin (stores cellular iron)
 - Decreased transferrin saturation (major iron transport protein)
 - **Increased total iron binding capacity**

OTHER DIAGNOSTICS

- History, physical examination (e.g. colonoscopy for GI bleed)

TREATMENT

MEDICATIONS

- PO iron supplements (e.g. ferrous sulfate)
- Parenteral iron
 - Severe, persistent anemia
 - Intolerance of PO iron
 - Nonadherence to PO supplements/dietary changes

OTHER INTERVENTIONS

- Increase dietary iron
 - Heme iron (e.g. meat) absorbed better than non-heme iron (e.g. eggs, legumes, nuts)
 - Vitamin C increases absorption; calcium decreases absorption
- Blood transfusion

LEAD POISONING-RELATED ANEMIA

osms.it/lead-poisoning

PATHOLOGY & CAUSES

- Lead exposure, toxicity → anemia
- Lead absorbed through lungs/skin/GI tract
 - Interferes with enzymatic steps in heme pathway → **decreased hemoglobin synthesis**, microcytosis
 - Impairs sodium/potassium ATPase in erythrocyte cell membrane → hemolysis

RISK FACTORS

- Water contaminated with industrial waste/ from pipes made of lead/that contain lead solder
- Exposure to leaded paint/paint dust/chips (esp. children); increased risk in older homes (built before 1978, lead in paint since banned)

- Exposure to soil/dust contaminated with lead
- Breathing industrial emissions containing lead (e.g. smelters, refineries, battery manufacturing, recycling)
- Food/ beverages from lead-glazed ceramics

SIGNS & SYMPTOMS

- Small, hypochromic red blood cells → hypoxemia → decreased oxygen to tissues → tissue hypoxia → fatigue, dyspnea, activity intolerance
- Lead toxicity
 - Abdominal pain, headache, difficulty concentrating, muscle/joint pain, confusion, ataxia

DIAGNOSIS

LAB RESULTS

- ↑ serum blood lead level (BLL)
- **Basophilic stippling**
- ↓ or normal MCV
- ↓ mean MCH
- Hemolysis
 - ↑ indirect bilirubin, LDH
 - ↓ haptoglobin

TREATMENT

OTHER INTERVENTIONS

- Eliminate exposure
- Chelation therapy
 - **Dimercaptosuccinic acid** (DMSA, AKA succimer), CaNa₂EDTA

THALASSEMIA

osms.it/thalassemia

PATHOLOGY & CAUSES

- Thallas = sea; emia = blood
- **Inherited hemoglobinopathies**; most common in individuals with Mediterranean, Middle Eastern, Southeast Asian, African genetic descent
- Hemoglobin synthesis with insufficient globin chains → impaired erythropoiesis, malfunctioning erythrocytes
- Autosomal recessive inheritance; wide range of phenotypes, clinical syndromes
- Deficient alpha/beta chains → imbalanced beta chain to alpha chain ratio → globin chains aggregate, precipitate in erythroid precursors → unstable hemoglobin tetramer
 - Impaired erythropoiesis
 - Intramedullary hemolysis and apoptosis
 - Small, hypochromic cells → decreased oxygen to tissues
 - Production of few microcytic, hypochromic erythrocytes with rigid, less deformable membranes → extravascular hemolysis, phagocytosis by reticuloendothelial macrophages

TYPES

Alpha-thalassemia

- **Deletion of ≥ one gene(s)** encoding alpha

globin chains → absent/ reduced chains

- **One gene missing: alpha-thalassemia minima**
 - **Benign** carrier state
- **Two genes missing: alpha-thalassemia minor**, alpha thalassemia trait
 - **Mild anemia**
- **Three genes missing: hemoglobin H (HbH) disease**
 - Mild anemia/may require **periodic transfusions** (variable presentation)
- **Four genes missing: alpha-thalassemia major**, hydrops fetalis, hemoglobin Barts
 - **Incompatible with extrauterine life** due to inability to form normal hemoglobin; death occurs before/shortly after birth
 - Only hemoglobin Barts (Hb Barts) is produced; tetramers of gamma globulin, oxygen not delivered to fetal tissues
 - Severe anemia during fetal development → hydrops fetalis → heart failure, hepatomegaly, ascites, death

Beta-thalassemia

- Genetic mutations of one/both genes → **absent/reduced beta chains**
- **Mutation in one beta globin chain: beta-thalassemia minor**, thalassemia trait
 - Asymptomatic carrier state/mild anemia
- **Mutation in two beta globin chains:** reduced beta globin production → beta-thalassemia intermedia

- Heterogeneous presentation
- May become transfusion-dependent later in life
- **No beta globin chains produced: beta-thalassemia major**
 - Transfusion dependent

COMPLICATIONS

- Hemolytic, microcytic, hypochromic anemia
 - Chronic tissue hypoxia
 - Leg ulcers
 - High output heart failure
 - Hypermetabolic state → nutritional deficiencies (children: growth impairment)
- Extramedullary hematopoiesis → bone marrow hyperplasia, bone marrow widens, structural malformations (e.g. facial irregularity, osteoporosis, premature fusion of epiphysis in children)
- Hemolysis → increased bilirubin → gallstones
- Iron overload, deposition in tissue
 - Myocardium → arrhythmias, restrictive cardiomyopathy, heart failure
 - Pancreas, other endocrine glands → endocrinopathies (e.g. diabetes, thyroid dysfunction)
 - Liver → cirrhosis, hepatocellular cancer
 - Kidneys → renal insufficiency (metabolic load from high hematopoietic cell turnover)
- Hydrops fetalis
 - Alpha thalassemia major only
- Treatment-related complications
 - Transfusions, chelation therapy

SIGNS & SYMPTOMS

- With exception of alpha-thalassemia major, mild compared to beta-thalassemia
- Decreased oxygen to tissues
 - **Systemic:** pallor, fatigue, activity intolerance
 - **Cardiac:** altered hemodynamics, e.g. tachycardia, low blood pressure, arrhythmias

- Chronic hemolysis
 - Jaundice, dark urine, hepatosplenomegaly

DIAGNOSIS

LAB RESULTS

- ↓ serum hemoglobin
- Decreased/normal/increased reticulocyte count → degree of impaired erythropoiesis
- White blood cells, platelets normal
- Red blood cell indices
 - Hypochromic-microcytic erythrocytes
 - MCHC increased related to erythrocyte dehydration
 - Decreased MCV
 - High red cell distribution width (RDW)
- Blood smear analysis
 - Poikilocytosis (dacryocytes, i.e. teardrop-shaped cells)
 - Anisocytosis
 - Erythroblasts (nucleated red blood cells)
 - Target cells
 - Inclusions (precipitated globin chains)
- Blood chemistry indicative of hemolysis
 - Increased lactate dehydrogenase (LDH)
 - Increased indirect (unconjugated) bilirubin
 - Decreased haptoglobin
- Iron studies
 - Increased serum iron, transferrin saturation (TSAT), serum ferritin
- Diagnostics to determine organ involvement (e.g. cardiac MRI, thyroid hormone, glucose levels, bone mineral density)
- Hemoglobin analysis using high-performance liquid chromatography (HPLC)/hemoglobin electrophoresis, genetic testing (confirmation)

TREATMENT

- According to phenotype

MEDICATIONS

- *Folic acid supplements*: support erythropoiesis

SURGERY

- Splenectomy

OTHER INTERVENTIONS

- *Blood transfusions*
- Chelation therapy
- Allogeneic hematopoietic cell transplantation (beta-thalassemia major)
- *Consultation with cardiology, other specialties*: organ involvement
- *Ongoing monitoring*: individuals with high impairment (e.g. blood, iron studies; liver studies; growth, development in children)